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CERCARIAE.

BY

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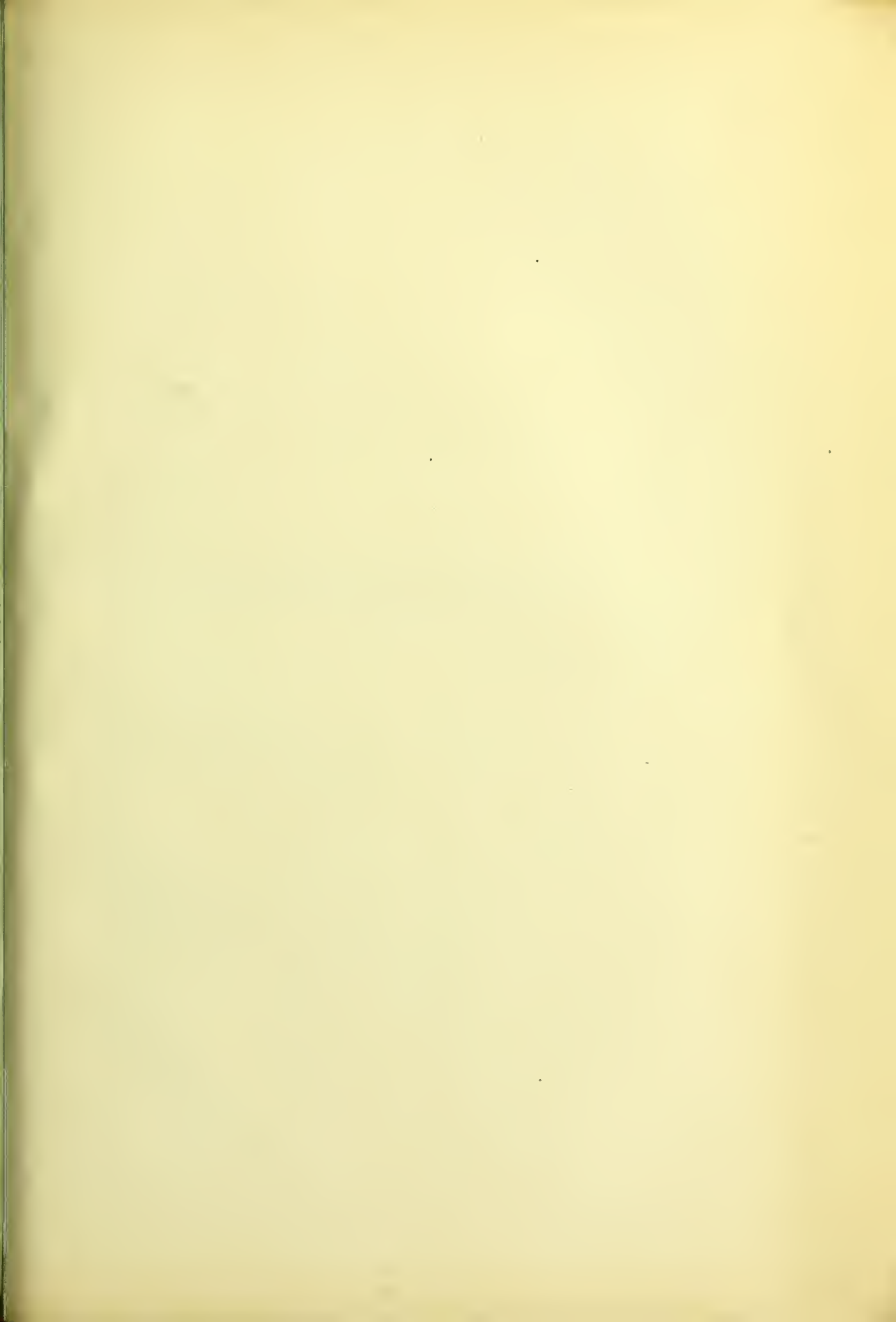
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FROM PARASITOLOGY, VOL. IV. No. 4, JANUARY 8, 1912



CAMBRIDGE
AT THE UNIVERSITY PRESS







[FROM PARASITOLOGY, VOL. IV. NO. 4, JANUARY 8, 1912]

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A REVIEW OF THE BRITISH MARINE CERCARIAE.

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(With Plates XXV—XXIX.)

General Life-History.

THE study of the life-histories of digenetic Trematodes is as yet in its infancy. Many new adult forms are described every year, but very little is known of the life-history of any of these. It is even impossible in the majority of cases to say what sort of larval form is characteristic of any group. Having worked for some years at the study of Trematode larvae I thought it would be of some use to bring together all the work so far done on British marine cercariae in order to form a nucleus round which future work may be centred.

As is to be expected more is known of the larval stages of bird Trematodes than of those inhabiting fish, as a great many sea birds are shore feeders and it is much easier to find cercariae in the shore animals than in those from the sea where the fish feed. It is only with fish and bird Trematodes that we deal in the present memoir.

From the fertilised digenetic Trematode egg issues a ciliated larva, the miracidium, possessing certain larval organs, which is free-swimming and after emerging from the egg in the water makes its way into some invertebrate host, the first host. This is in almost every case known a Mollusk, either Gastropod or Pelecypod. (The only exception known to me is that suggested by Pratt (1898, p. 351) who thinks it probable that a Hemiuroid larva develops from a miracidium in a Crustacean host, namely a Copepod¹.) Having bored its way into this host the larva settles down in some organ, usually the digestive gland or gonad,

¹ The larva of the human Trematode *Bilharzia* is apparently capable of direct infection.

loses its larval organs and degenerates into a sac, the sporocyst. From the cells of the walls of the sporocyst are budded off germ balls which usually grow into a different kind of larva, the redia, which bursts from the sporocyst and leads a free existence in the host. The sporocyst may however by budding proliferate without forming rediae and may form sporocysts within it instead of rediae. The sporocyst is merely a sac and has no alimentary canal, imbibing its food through the body wall; the redia on the contrary has a well-developed sac-like intestine and a mouth at the anterior end with a strongly muscular pharynx. It may also have a thickening round the anterior end of the body, the "collar," a birth-pore usually near the pharynx as exit for the cercariae, and at the posterior end two ambulatory projections which help it in progression. These latter organs may be entirely absent and frequently the ambulatory processes are only present in the young forms, probably because the redia migrates in its young state to some other organ of its host. Both sporocyst and redia may be coloured yellowish or a brilliant orange; the intestine of the redia is often brown.

The redia, or, in those cases where the redia stage is omitted, the sporocyst now forms within it another kind of larva, the cercaria, which has the real Trematode form and gradually grows within its "nurse" from a shapeless mass of cells to a worm which shows more or less of the adult characteristics. Typically the cercaria has a tail and when it is full-grown it emerges from the redia or sporocyst. If the birth-pore is present in the redia the cercaria comes out in this way without rupturing the redia body wall, in the other case it bursts through the wall which closes up after it. All stages may be in the redia or sporocyst at the same time, from shapeless germ balls to the full-grown cercaria. The tailed cercaria now leaves its host altogether and swims about in the water for a little while. It then either comes to rest on some inanimate object (*e.g.* a blade of grass as in the Liver Fluke) and losing its tail forms round itself a cyst and rests, or it makes its way into another host, the second or intermediate host, and here it rests, usually forming round itself a cyst (in exceptional cases such as the "Pearl Trematode" a cyst is formed round the cercaria not by the worm itself but by the epithelium of its molluscan host). Up to a certain point the cercaria may feed and grow in its second host but afterwards it always has a real resting stage which is comparable to the pupal stage of a butterfly. The suckers, alimentary canal and excretory system are usually formed in the cercaria before it leaves its first host and parts of the reproductive system are sometimes developed. The

alimentary canal however is not always formed so soon, especially in those forms in which extremely large unicellular glands occupy the greater part of the body. There are two kinds of glands which are sometimes very conspicuous in the cercaria, the cystogenous glands which secrete the material for the cyst and those glands which always are present if a boring spine or stylet occurs in the oral sucker. These latter glands are the "Stacheldrüsen" or stylet-glands which help the worm to bore into its host, the stylet piercing and the glands pouring out their fluid at the same time. Both cystogenous and stylet glands may be present or only one kind. The cystogenous glands sometimes occupy almost the whole of the body as in some of the Echinostomes, others occur in small masses; all open by ducts near the oral sucker. The stylet glands disappear after the cercaria has successfully entered its second host. The cystogenous glands disappear after the cyst is formed, as does also the tail. The intermediate host may be a Vertebrate or an Invertebrate. In marine Trematodes fish serve as Vertebrate intermediate hosts, the cercariae often encysting under the skin, in the muscles, nerves and various organs. Crustacea and Mollusca are the usual Invertebrate hosts; crabs and Amphipods are very commonly infected, the cercariae occurring in the liver, gonads or muscles. In Mollusca the foot, mantle, digestive gland or gonad serve the purpose. Nearly always the intermediate host, if a Mollusk, is a Pelecypod. In some cases the encysted stage takes place within the sporocyst. Here the life-history is much abbreviated and often the cercaria is tailed but loses its tail before it encysts. In other cases the resting stage is omitted because the final host swallows the redia with cercariae; here again we find the cercaria loses its tail before it is full grown.

In one group, the *Gymnophallus* group, the cercaria is always without a tail, and apparently has to reach its host by creeping movements or depend upon currents to sweep it along. This was noticed by Jameson (1902, p. 160), who found that because of the cercariae of the "Pearl Trematode" not having tails only those mussels fixed on the ground were much infected with pearls; those clinging to wood above were almost free from them.

Classification of Cercariae.

Lühe (1909, p. 173) has classified the various cercariae according to their tails but there appears to me to be something to be said against this method, excellent though it be in many ways. The chief objection seems to be that certain forms, which by their organisation are clearly

very nearly related, are absolutely separated in this way, because in some of them owing to an abbreviation of the life-history the cercaria has lost its tail. In the *Spelotrema* group as described below we have a free-swimming tailed cercaria in *Spelotrema excellens*, cercariae such as *Cercaria oocysta* in which the young forms possess tails but do not use them (as encystment takes place in the sporocyst, where they are cast off), and finally in *Cercaria littorinae-rudis* we have most certainly one of the *Spelotrema* group which appears to lack a tail altogether. We are not justified in such a case, I think, in placing these cercariae in different divisions because of the presence or absence of a tail. Again *Acanthopsolus lageniformis* loses its tail before emerging from the redia. As a full-grown cercaria it is tail-less, but it is much more closely related to the *Echinostomum* group than to the tail-less cercaria group. So far as we know at present the *Gymnophallus* group is the only one in which the cercaria throughout has no tail, and this is a very well-marked group; the fork-tailed cercariae (e.g. *C. dichotoma*) however seem to be closely related. It seems to me therefore that the tail is not of so great importance primarily in classifying cercariae as is the question whether it develops in sporocysts or rediae and I have therefore made two primary groups:

I. Developing in sporocysts. *Gasterostomum* group. *Gymnophallus* group. *Cercaria dichotoma*. *Spelotrema* group. Group of stumpy-tailed cercariae. *Lepodora*.

II. Developing in rediae. *Cercaria neptuneae*. *Acanthopsolus*. *Echinostomum* group. *Monostomum* group.

From this classification I have omitted all fresh water forms that are not also marine and have restricted myself to those already known in Britain.

We divide the digenetic Trematodes into *Gasterostomata* and *Prostomata* according to whether the oral sucker is median or, as is usually the case, at the anterior end. This division is as clearly marked in the larval forms as in the adults. As well as having the sac-like intestine opening in the centre of the body the *Gasterostomatous* cercaria, which is known as *Bucephalus*, is provided with a peculiar and very characteristic tail having two long lateral filaments by aid of which it swims.

The *Prostomata* may then be sub-divided into groups some of which stand out much more conspicuously than others, but this is probably because they are more completely known; such groups are the *Spelotrema* group and the *Echinostomum* group, both of which are

parasitic in birds. Others are difficult to place such as *Lepodora* and *Cercaria neptuneae*, but very little is known of these and further investigation will no doubt elucidate matters. When several species are known which undoubtedly belong to the same group we find them extraordinarily constant as to the kind of hosts they inhabit, thus all the members of the *Echinostomum* group so far as is at present known develop in rediae in the digestive glands of Gastropods, have a free-swimming stage and encyst in another molluscan host, in two cases known in the foot. Members of the *Spelotrema* group develop in sporocysts in Mollusca (Gastropods or Pelecypods) and encyst in Crustacea, except where the life-history is abbreviated and encystment takes place within the sporocyst in the first host. The members of the *Gymnophallus* group all seem to live for a time free between the mantle and shell of a Mollusk, usually a Pelecypod.

It seems to me that we know too little of these cercariae to attempt at present to classify them further in relation to their adult forms. I therefore have divided up the *Prostomata* into certain groups each of which is characterised in some definite way, but it is not intended to show any relationships between these groups other than the general resemblance of their larval stages.

I. GASTEROSTOMATA.

Cercaria developed in sporocysts.

Sporocysts occur in Pelecypoda, long and winding, branched or unbranched.

Cercaria known as *Bucephalus*.

Cystogenous organ anterior, ventral sucker opening into sac-like intestine. Tail a broad case with two lateral, very contractile and long filaments for swimming.

Intermediate host—a fish.

Final host—a fish.

II. PROSTOMATA.

A. (Two suckers.)

1. *Developed in sporocysts.*

(a) *Gymnophallus* group. Cercaria tail-less, developed (in the only species in which the sporocysts are known) in more or less spherical sporocysts in Pelecypoda. Oval body covered with spines.

No prepharynx, conspicuous pharynx : short and broad intestinal caeca seldom reaching beyond ventral sucker. Ventral sucker always behind centre of body. Excretory vesicle large, forked, reaching far forward anteriorly.

Intermediate host usually a Pelecypod. Cercaria lives between mantle and shell, finally settling down in the tissues of its host which forms a cyst round it of epithelial cells, the cercaria itself not forming a cyst.

Final host a bird, usually of the Duck tribe.

(b) *Group of fork-tailed Cercariae*. These seem closely allied to *Gymnophallus* but further life-history not known. Cercaria very like *Gymnophallus* but with excretory vesicle continuing down tail and opening at end of each fork. Develops in sausage-shaped sporocysts in Pelecypoda.

(c) *Spelotrema* group. Cercaria developed in sporocysts, spherical or oblong, in Gastropods. May have a free-swimming stage and in that case (e.g. *Spelotrema excellens*) is very small, oval and transparent with a thin tail about as long as or slightly longer than the body, provided with a boring stylet anteriorly and large stylet glands. If free-swimming stage is not present the cercaria is like the adult, tongue-shaped, covered more or less with spines, with long prepharynx and oesophagus, short intestinal lobes, not reaching to end of body. Tail may be completely absent or present in young stages of those which encyst in the sporocysts.

If intermediate host is required it is a Crustacean in which the cercaria encysts.

Final host—a bird.

(d) *Group of stumpy-tailed Cercariae*. Cercaria developed in sausage-shaped sporocysts, often brightly coloured, in Gastropoda. Very small and transparent. Suckers almost of the same size. Oral sucker provided with a stylet and conspicuous stylet glands. Excretory vesicle very thick-walled. Tail very broad and stumpy.

Further life-history unknown.

(e) *Lepodora*. Only one species of cercaria known, oval, covered with spines. Intestinal lobes reaching nearly to posterior end of body. Tail present in young form, cast off before encystment which takes place within the sausage-shaped sporocysts in a Pelecypod.

Final host—a fish.

2. *Developed in rediae.*

(a) *Cercaria neptuneae*. Cercaria developed in redia in a Gastropod, very thick and large tail, two eye-spots present. Stylet glands(?) and cystogenous glands. Excretory vesicle very thick-walled.

Further life-history unknown.

(b) *Acanthopsolus*. Cercaria developed in redia in a Gastropod, two eye-spots, intestinal lobes reaching nearly to posterior end of body, thin tail developed in young forms which is cast off before it is full grown.

Encysted stage and intermediate host probably omitted.

Final host—a fish.

(c) *Echinostomum* group. Cercaria developed in redia in a Gastropod. Redia usually coloured yellow or orange, provided with a collar, birth-pore and ambulatory processes. Cercaria with well-marked head end provided with crown of spines. Intestinal lobes reaching nearly to posterior end of body. Excretory system with small posterior vesicle and two conspicuous lateral canals. Tail long and narrow. Free-swimming stage.

Intermediate host—a Mollusk or fish.

Final host—Mammal, bird or fish.

B. (With one sucker only.)

(d) *Monostomum* group. Cercaria developed in rediae in a Gastropod. Eye-spots, tail long. Free-swimming stage. Encysted stage perhaps free.

Final host—a bird or fish.

Description of Material.

Nearly all the cercariae referred to in the following notes have been seen by myself and drawings made from the living objects. A few have been copied from others when I could not get specimens, and for these I have to thank Dr William Nicoll and Mr Jas. Johnstone.

Most of the work has been carried on at the Dove Marine Laboratory, Cullercoats, through the kindness of Armstrong College, Newcastle-upon-Tyne. Part of it was done at the Marine Station, Millport, and the Marine Laboratory, Plymouth, and I have also done a good deal of it at Leeds University.

In the course of my work I have examined material at many different times of year, and find that in nearly every case the sporocysts,

rediae and cercariae are formed most abundantly in the spring, summer and early autumn,—scarcely at all in the winter. The encysted stages, however, are to be found through the winter, and it seems that these are real resting stages in which the larva has ceased to feed and is gradually forming its reproductive organs and getting ready for its adult life.

Effect of Parasite on Host.

The presence of sporocysts and rediae certainly injures the Molluscan host. The outer appearance of the digestive gland is usually enough to show if it is inhabited by these parasites. It looks unhealthy and is a grey, sickly yellow or a peculiar unnatural orange. It is generally completely riddled with the sporocysts or rediae which feed upon its substance. If the gonad is infected it is quite destroyed.

On the other hand encysted cercariae seem to do little or no harm to their hosts even when present in great numbers; they may even be of economic importance, as in the formation of pearls.

Many larval Trematodes infest our edible shell-fish. For instance *Bucephalus haimeanus* entirely spoils the cockles which it occupies. Many sporocysts and rediae occupy the digestive gland of periwinkles and *Buccinum* rendering it not a digestive gland at all but simply an organ full of parasites. The edible crab *Cancer pagurus* is also very often crowded with the cysts of *Spelotrema excellens* although this does not appear to affect the tissues in any way.

The following is a list of Trematode larvae occupying some of our most important edible shell-fish :

- (1) In *Littorina littorea* (the periwinkle)
 - Cercaria linearis* (kidney and mantle cavity)
 - Echinostomum secundum* (digestive gland)
 - Cercaria lophocerca* (digestive gland)
- (2) In *Buccinum undatum* (the "buckie")
 - Cercaria buccini* (digestive gland)
 - C. neptuneae* (digestive gland)
 - Acanthopsolus lageniformis* (digestive gland)
- (3) In *Cardium edule* (the common cockle)
 - Bucephalus haimeanus* (throughout body)
 - Gymnophallus margaritae* (under umbo)
 - Lepodora rachiaea* (?) (visceral mass)
 - Echinostomum secundum* (foot)

- (4) In *Mytilus edulis* (the common mussel)
 - Echinostomum secundum* (foot)
 - Gymnophallus margaritae* (between mantle and foot)
- (5) In *Cancer pagurus* (the edible crab)
 - Spelotrema excellens* (all over body).

Systematic Section.

I. GASTEROSTOMATA.

Genus *Gasterostomum*

Gasterostomum gracilescens (Rud.) (Lebour, 1908 B, p. 8).

Larval form *Bucephalus haimeanus* Lacaze-Duthiers.

(Pl. XXV, figs. 1-4.)

This is the well-known oyster parasite. In Britain however it has only been observed in the cockle *Cardium edule* L., but always in the vicinity of oyster beds. It occurs in two per cent. of the cockles from Fenham Flats, Northumberland, and more commonly in the same Mollusk from Emsworth, Hampshire (in about 10 per cent. of those which live near the oysters). For the specimens I am indebted to Miss Florence Jewell of Emsworth, who kindly sent me them on several occasions. Johnstone (1904, p. 106) has recorded a specimen of *Cardium edule* from the Lancashire coast infested with the parasite.

The cercaria occurs in very long sporocysts which are irregularly branched at intervals and so tangled together that it is almost impossible to separate them (fig. 1). They are packed closely together all over the body except the foot, completely destroying the gonad. Inside the sporocysts are the *Bucephalus* cercariae in all stages. The full-grown cercaria (fig. 2) measures 0.26 mm. in length without the tail which is extremely contractile and may be many times longer than the body. The tail is a very characteristic organ consisting of a triangular median portion at the hind end of the body bearing on each side a lateral process which is thin and elastic, alternately contracting and expanding as the cercaria swims. The body is covered, except at the tail, with minute spines arranged in transverse rows which give it a striated appearance. The mouth is in the centre of the ventral sucker which leads to a simple sac-like intestine. At the anterior end of the body is a sucker-like cystogenous organ. Posteriorly is a clear pear-shaped excretory vesicle.

The encysted stage of what is almost certainly the same worm occurs in the nerve cord and nerves of various Gadidae, most commonly the haddock *Gadus aeglefinus* L. Williamson (1911, p. 60) has recently recorded these cysts from the skin as well as the nerves of Gadidae. It was Dr David Hilt Tennant (1906, p. 635) who, working at the life-history of the American *Bucephalus haimeanus*, discovered its identity with some species of *Gasterostomum*, but I doubt if it be the same species as the British form although very similar. He found the encysted stage in the silverside *Menidia menidia* and the adult in the gar *Tylosaurus marinus*. The cysts in the nerves of the haddock are the "Bodies of Munro" of Maddox (1867, p. 87). They occur particularly in the region of the auditory and spinal nerves. They are also common in the cod *Gadus morrhua* L., and the whiting *G. merlangus* L., Johnstone (1904, p. 101) records it from the Lancashire coast in *Phycis blennioides* and also from the cod and haddock.

The cysts (fig. 3) are oval and thin-walled appearing as little bead-like swellings along the nerves. Length of cyst 0.60 mm. The cercaria coiled up inside is quite colourless with a very conspicuous opaque excretory vesicle. When pressed out of the cyst it measures about 2.5 mm. in length and is covered with minute spines (fig. 4). At about the first quarter of the body is the ventral sucker leading to a sac-like intestine. At the anterior end is a sucker-like organ. The excretory vesicle is long and narrow not reaching quite so far as the ventral sucker. A pair of testes is situated obliquely one behind the other in the posterior third of the body, the two ducts from these uniting in a common vas deferens which is continuous with the posteriorly situated vesicula seminalis and cirrus sac, the genital pore opening at the hind end of the body. The ovary is situated between the testes and the ventral sucker; the uterus and shell gland complex are present though not fully formed and no eggs are as yet developed. This encysted form is certainly identical with *Gasterostomum gracilescens* which lives in great numbers in the stomach and pyloric caeca of the angler *Lophius piscatorius*; all stages can be traced in it from forms exactly corresponding with the cercaria pressed out of the cyst from the haddock to the adult form full of eggs. The angler feeds on fish of all kinds, notably Gadoid, and so easily gets the worm into its alimentary canal. Nicoll (1909, p. 24) found immature specimens of this worm in the stomach of a cod. As he says, it probably got there by its swallowing some other Gadoid, and almost certainly it would not develop any further in the cod.

Gasterostomum sp.*Bucephalus syndosmyae* sp. inq.

(Pl. XXV, figs. 5, 6.)

This cercaria occurred once out of five specimens of *Syndosmya alba* from Millport, Scotland, in July. Pelseneer (1906, p. 176) records *Bucephalus haimeanus* from this Mollusk, but this is certainly distinct.

The sporocysts riddled the whole animal but especially the digestive gland and region of the gonad. They are very long, thread-like and unbranched and contain cercariae in all stages (fig. 5). The full-grown cercaria which was bursting from the sporocyst is very like *B. haimeanus* (fig. 6). The ventral sucker (0.01 mm. across) which leads to the sac-like intestine is behind the centre of the body instead of in front. The body is covered with small spines. Anteriorly is a sucker-like cystogenous organ 0.03 mm. long by 0.02 mm. broad, or circular according to the state of contraction. Posteriorly is the tail with long processes. The centre of the tail is partially divided posteriorly by an indentation.

Further stages of the life-history are not known.

Besides these cercariae are to be noted encysted *Gasterostomatous* Trematodes found by Johnstone (1904, p. 103) in the muscles of small plaice. These were sexually mature and the uterus was full of eggs. This worm seems more nearly related to the genus *Proisorhynchus* than to *Gasterostomum*.

II. PROSTOMATA.

1. *Cercariae developed in sporocysts.*(a) *Gymnophallus* group.Genus *Gymnophallus* Odhner.

Cercaria margaritae sp. inq. (= the Pearl Trematode of Jameson (1902)).

(Pl. XXV, figs. 7, 8.)

This is referred by Jameson to *Leucithodendrium somateriae* (Levinsen) but Odhner (1905, p. 312) thinks it resembles *Gymnophallus bursicola* more closely, and Nicoll (ix. 1907, p. 265) is of the opinion that it may be *G. dapsilis*. It is extremely difficult without infection

experiments to say which it is when so many of these closely similar species are common in the same host.

The young cercaria occurs in sporocysts in *Cardium edule* and *Tapes decussata*. The sporocysts are simple, more or less spherical sacs, quite colourless, some large and some small, Jameson (1902, p. 153) found them in *Tapes* in the muscular or connective tissue of the mantle margin, particularly dorsally, close to the siphonal muscles. He thinks that they increase by budding and grow as the Mollusk grows. In between the sporocysts are often to be found chalky spots, the development of which Jameson regards as due to the compression of the tissues, owing to the growth of the sporocyst and this interferes with the secretion of fresh shell layers; hence these white chalky masses.

Cardium edule was also found by Jameson to be a host for the sporocysts and these also occurred in the mantle margin. Afterwards Nicoll (I. 1906, p. 149) at St Andrews and myself (1907 A, p. 18) in Northumberland found these sporocysts very frequently in *Cardium edule* but not usually in the mantle margin. The usual habitat was just under the umbo where they occurred as a jelly-like mass frequently with the chalky spots mixed with them. The cockles of Fenham Flats and Budle Bay, Northumberland, were very commonly infected by this parasite. I also found it in the cockles at Millport.

The sporocysts (fig. 7) contain the cercariae (fig. 8) which measure when fully formed 0.15–0.3 mm. in length, the body covered with spines, a pair of brown eye-spots at the anterior end, one on each side of the oral sucker. The ratio of the oral to the ventral sucker is about 2:3. The lobes of the intestine do not reach so far as the ventral sucker and have no food inside. The testes and traces of the other reproductive organs can be seen in dead specimens only. The excretory sac is large with its lateral forks reaching as far as the pharynx.

The cercaria presumably leaves its first host and by aid of currents or by crawling on the ground by aid of its suckers, reaches its intermediate host, *Mytilus edulis*. Here it settles down between the mantle and shell, feeds and grows and finally makes its way into the tissues of the mantle, curls itself up and rests. It does not itself secrete any cyst but the mantle cells grow round it and form an enclosing sac of epithelium. Jameson believes that the parasite stimulates the mantle parenchyma to form these epithelial-like cells which are capable of secreting a pearly-layer round the parasite. The cercaria may make its escape from the sac before the pearly-layer is formed otherwise it dies forming a nucleus for the pearl.

The final host is almost certainly one of the ducks. Jameson believes it to be the scoter *Oedemia nigra* L. which eats mussels voraciously. Nicoll's *G. dapsilis* was also from the scoter *O. nigra* and the velvet scoter *O. fusca*.

Cercaria scrivenensis sp. inq.

(Pl. XXV, fig. 9.)

This was found on one occasion in *Tapes pullastra* from Loch Scriven, the Clyde, in August. Two examples occurred in one individual between the mantle and shell. It appears to be different from the other *Gymnophallus* cercariae so far known. Length 0.4 mm., breadth 0.24 mm. Body covered with spines. Oral sucker 0.09 mm. across, ventral sucker 0.03 mm. across. Intestinal caeca reaching a good way beyond the ventral sucker. Pharynx 0.03 mm. long. Excretory system conspicuous, forks reaching to pharynx.

Further life-history unknown.

Cercaria glandosa mihi (1908 A, p. 4).

(Pl. XXV, fig. 10.)

This occurs in *Paludetrina stagnalis* from Fenham Flats and is the only *Gymnophallus* cercaria known that inhabits a Gastropod. It is always free between mantle and shell. Only one to six specimens occur in the same individual. It is not certain whether this is the first or the intermediate host as no sporocysts were found. From the scarcity of specimens it seems more likely that it is the intermediate host.

The cercaria measures 0.20 mm. in length, very contractile, head region contains numerous gland cells filling up the space between body wall and oral sucker and opening by ducts round the dorsal margin of the oral sucker. It is possible that these are cystogenous glands and that in this form there is an encysted stage. Oral sucker 0.05 mm. across, ventral sucker 0.033 mm. with inner margin crenulated. Small pharynx leading to short oesophagus, intestinal caeca extending to beyond the centre of the ventral sucker, usually black with contained food. Excretory vesicle large, forks not reaching as far as pharynx. Testes developed on each side of excretory vesicle.

Further life-history unknown. Possibly this and not *C. margaritae* is the cercaria of *G. somateriae* which inhabits the intestine of the Eider Duck *Somateria mollissima*.

Cercaria macomae mihi (1908 A, p. 6).

(Pl. XXV, fig. 11.)

In *Macoma balthica* from Fenham Flats, occurring between mantle and shell, not more than three in any one specimen, three out of 20 examined contained them. The cercaria measures 0.70 mm. long. Oral sucker 0.22–0.26 mm. Ventral sucker 0.06–0.07 mm. with a crenulated inner margin. Small pharynx, short oesophagus, intestinal caeca reaching not quite to the level of the centre of the ventral sucker. Excretory vesicle horse-shoe shaped. Testes present, ovary in front of right testis, oval and slightly smaller than testis. Vitellaria lie below and to right side of ventral sucker.

Further life-history unknown.

Cercaria strigata mihi (1908 A, p. 7).

(Pl. XXV, fig. 12.)

In *Tellina tenuis* and *Donax vittatus* from Alnmouth, Northumberland, between mantle and shell in every specimen of *Tellina* examined (about 20) and in one *Donax* out of a dozen. It also occurs in 3 per cent. of *Tellina tenuis* at Millport. The body spines are very conspicuous and stand out in ridges giving the worm a striated appearance. Length 0.30–0.40 mm., oral sucker 0.09 mm., ventral sucker 0.052 mm. Small pharynx, 0.03 mm. long, short oesophagus, intestinal caeca broad and almost circular, reaching a very little way beyond the anterior margin of the ventral sucker. Excretory vesicle lyre-shaped. Testes sometimes to be seen one on each side of excretory vesicle. Hind part of body peculiar in being slightly drawn out at the end so as to give it the appearance of having a short tail. Giard (1907, p. 416) regarded this cercaria as very probably the young of *G. somateriae*, I think however, as I have suggested in a former paper (1908 A, p. 9), that it is more likely to be the young form of some *Gymnophallus* inhabiting a bird other than a duck, perhaps a gull.

(b) *Fork-tailed Cercariae.**Cercaria dichotoma* Müller.

(Lebour 1908 A, p. 13.)

(Pl. XXVI, figs. 1, 2.)

This cercaria seems to be closely allied in structure to *Gymnophallus* although the presence of the forked tail seems to warrant its being placed in a separate group¹. It occurs in long irregular sporocysts in the little bivalve *Scrobicularia tenuis* from Fenham Flats in 1 out of 50. The sporocyst measures about 1 mm. in length, very transparent and full of cercariae in all stages. The cercaria measures 0.20 mm. in length with the tail which is slightly shorter than the body and forked at its free end. Oral sucker 0.033 mm. across leading directly to pharynx, 0.016 mm. long. Rather long oesophagus, intestinal caeca reaching a little way beyond the anterior margin of the ventral sucker. Ventral sucker lying well behind the centre of body, 0.029 mm. across. Excretory vesicle lyre-shaped, occupying most of the posterior part of body and continued right along tail where it opens at the end of each fork.

Johnstone (1904, p. 107) records it from *Cardium edule* from the Lancashire coast.

The further life-history is not known. I should say the adult must be closely related to *Gymnophallus*. The form of the intestine, excretory vesicle and position and relations of the suckers all indicate a near relative of this genus. The final host is almost certainly a bird.

(c) *The Spelotrema group.*

The adults of this group all live in birds and are very much alike. The intermediate host if present is a Crustacean in which the cercaria encysts. The cercaria in the cyst can always be recognised as belonging to this group as it is very like the adult except that the reproductive organs are not fully developed. The typical cercaria, like the adult, is tongue-shaped, covered more or less with spines, more pointed anteriorly than posteriorly, very much flattened dorso-ventrally, suckers nearly equal, prepharynx usually long, pharynx long, oesophagus branching into short intestinal caeca which rarely reach beyond the ventral sucker. It is generally difficult to make out much more of these cercariae and

¹ Odhner (1911, p. 105) describes a fork-tailed cercaria which he believes to be a species of *Haplocladus*.

therefore it is hardly possible to ascribe them to different genera. The genera *Spelotrema*, *Maritrema*, *Levinsenia*, *Levinsiella* are very much alike and are only differentiated by their reproductive and excretory organs. It is sometimes easy to see the genital opening and papilla in the *Spelotrema* cercaria, and in one species *S. excellens* Nicoll I have been able to follow out most of the life-history.

Some forms of this group encyst in their sporocysts in Gastropod hosts and these I think may possibly belong to the genus *Maritrema*.

There are two distinct kinds of cercariae in the *Spelotrema* group. One in which the cercaria has a free-swimming stage and is provided with a stylet and stylet glands. This is at first quite unlike the encysted form and gradually assumes the adult characteristics within the cyst. Such cercariae occur in *S. excellens* and *S. balani*. The other kind is like the encysted form even within the sporocysts, apparently possessing no tail at any period of its existence. This is the case with *Cercaria littorinae-rudis*. In such forms which encyst in the sporocyst the cercaria is at first tailed but gradually assumes the ordinary *Spelotrema* form, loses its tail and encysts.

Genus *Spelotrema* Jägerskiöld.

Spelotrema excellens Nicoll (x. 1907, p. 248).

(Pl. XXVI, figs. 3-10.)

The encysted cercaria which for excellent reasons Nicoll regards as *S. excellens* occurs in the common green crab *Carcinus maenas* in almost every organ and seems to be universally distributed in Britain. The first to describe this cercaria from the crab was McIntosh (1865, p. 201) who found it abundantly at St Andrews from the crabs in the rock pools. It was afterwards described by Nicoll and Small (1909, p. 238) from Millport, and I have found it commonly at Plymouth and on the Northumberland coast.

The first host of this Trematode has not as yet been described but I believe the very active and extremely small cercaria which is common in many places and which I have named *Cercaria ubiquita* (1907, p. 444) to be a stage in the life-history. It never occurred to me to identify this little creature with the encysted *Spelotrema* from the crab until after pondering over the question of its life-history at Millport and examining many Mollusca and crabs I was able to follow up the various stages of *Cercaria ubiquita* and found that it entered the crab, and there underwent changes until it finally turned into a *Spelotrema*-like cercaria.

Cercaria ubiquita is common in *Paludestrina stagnalis* at Fenham Flats and Loch Ryan on the West Coast of Scotland. Occasionally also I have found it in *Littorina obtusata* and *Littorina rudis*. At Millport *Littorina obtusata* from the rock pools where the crabs live is its usual host. It occupies the digestive gland in oval sporocysts and the whole of the organ has an unhealthy yellowish colour and can generally be quite easily told from an ordinary healthy digestive gland.

The sporocysts (fig. 3) are oval and of various sizes, the usual size being about 0.6 mm. long. They are pinkish yellow when together but almost colourless when looked at singly. Cercariae in all stages are contained within which easily burst out of the thin-walled sporocyst.

The cercaria (fig. 4) measures 0.12 mm. in length without its tail which is about the same length as the body and very thin and active. It is extremely transparent. The oral sucker measures about 0.030 mm. across but often appears oval when extended. It is armed with a long pointed stylet and by its sides open the four ducts (two each side) of the stylet glands which run up the body springing from two masses of large cells which occupy the greater part of the body. No ventral sucker is to be seen. It apparently develops afterwards as does also the alimentary canal. The excretory vesicle is bilobed. The tail very easily detaches itself and moves about separately. The cercaria is fond of doubling itself up with its fore and hind ends doubled in so that it looks like a neatly folded parcel. It apparently leaves its first host and swims freely about in the water, then bores its way by means of its stylet and glands into the tissues of the crab. The edible crab *Cancer pagurus* is also an intermediate host for this worm. I have found cercariae exactly corresponding with *C. ubiquita*, but without the glands, inside the tissues of *Carcinus maenas*. I have also found it curled up and surrounded by a very thin cyst, 0.08 mm. across (fig. 5). It has now lost its tail but the stylet remains for some time longer. It occupies almost every tissue of the crab, liver, muscles, gonad and outside the blood vessels. Having settled down it grows considerably and the cyst with it, but the latter however is still very thin-walled. The stylet is lost when the cyst measures about 0.30 mm. across. The ventral sucker and alimentary canal appear and the body spines begin to form. The worm stops growing when the cyst is about 0.35 mm. across and then the cyst wall becomes very thick, 0.02 mm. thick and the real resting stage begins. The cercaria is now of the ordinary *Spelotrema* form. The usual size of the thick-walled cyst is 0.4–0.48 mm. across. It is very difficult to get the enclosed worm out of the

cyst without injuring it as the cysts are extraordinarily difficult to break through.

The cercaria when pressed out of the cyst measures about 0.8 mm. in length. Its body is covered with spines except at the posterior end. Oral sucker 0.066 mm. across, slightly larger than the ventral sucker. Prepharynx long, pharynx conspicuous, oesophagus long branching into two caeca which reach to about the level of the centre of the ventral sucker. The genital papilla is plainly to be seen on the left side of the ventral sucker and often the vesicula seminalis is apparent. The excretory vesicle is large and specially conspicuous in the hind part of the encysted cercaria, two lateral ducts are plainly to be seen opening into it. Testes one on each side behind ventral sucker. From what has been said there can be little doubt that *Cercaria ubiquita* is the young form of *S. excellens* the first host thus being *Paludetrina stagnalis*, *Littorina obtusata* and *L. rudis*. The intermediate host *Carcinus maenas* and *Cancer pagurus* and the final host probably the herring gull *Larus argentatus*.

The sporocysts and cercariae are not to be found in the winter and the crabs in the winter only contain the thick-walled cysts. The small thin-walled cysts are only to be found in the spring, summer and early autumn. This points to the summer and autumn as the time for the migration of the cercariae from the first to the intermediate host. The passing from *Carcinus* to its final host may almost certainly take place at any time of year.

The cercariae *C. cellulosa* and *C. pusilla* of Looss (1896, p. 227) probably belong to the *Spelotrema* group as they are very like *Cercaria ubiquita*. In that case the final host would be a bird and not an insectivore as the author suggests.

There are at least two other forms belonging to the *Spelotrema* group which encyst in the crab but which I have not been able to investigate in any detail. These are *Cercaria carcini* mihi and another small one which I have named *Cercaria minor*. The encysted cercaria with thick cyst mentioned by myself from *Carcinus* (1908 A, p. 11) is probably an unusually small example of *S. excellens*.

Cercaria carcini mihi (1908 A, p. 10).

(Pl. XXVI, figs. 13, 14.)

This was found encysted in *Carcinus maenas* from Fenham Flats. Only a few specimens were examined but in no case were the cercariae frequent. The cyst is oval and thin-walled, 0.40×0.35 mm. The cercaria when pressed out of the cyst measures 0.54 mm. in length, suckers almost equal, intestinal lobes reaching to the level of the anterior margin of the ventral sucker. Body covered with spines except at the posterior end. This is very like *S. excellens* but I think from the character of the cyst that it is a different species.

Cercaria minor sp. inq.

(Pl. XXVII, figs. 1, 2.)

Occurs in smaller cysts than *S. excellens* but with them in *Carcinus maenas*. The cyst wall is much thinner. Breadth of cyst 0.26 mm. The cercaria contained within it is well developed and certainly distinct from *S. excellens*. Length 0.52 mm. Body covered with spines except at the posterior end. Oral sucker 0.46×0.40 mm., broader transversely. Ventral sucker 0.40 mm. Prepharynx and oesophagus long. Intestinal caeca reaching to just beyond the posterior border of the ventral sucker. Genital pore to left of ventral sucker. Testes and vitellaria behind.

The further life-history is not known.

Cercaria corophii mihi (1908 A, p. 9).

(Pl. XXV, figs. 18, 19.)

This cercaria occurs frequently encysted near the surface of the body and legs of the amphipods *Corophium grossipes* and *Gammarus duebeni* especially in the former, just beneath the cuticle. All those found were from Fenham Flats. The cyst is slightly oval 0.16×0.14 mm., with thick transparent walls. When pressed out of the cyst the cercaria measures 0.34 mm. in length, broad at the base with head end tapering. Body covered with spines except at the posterior end. Oral sucker 0.03 mm. across, narrow prepharynx 0.04 mm. long, pharynx 0.016 mm., long oesophagus branching into caeca reaching just beyond the posterior border of the ventral sucker. Ventral sucker 0.023 mm. across.

Nothing further of the life-history is known.

Cercaria balani mihi (1908 A, p. 10).

(Pl. XXVI, figs. 15, 18.)

Occurs encysted in the common barnacle *Balanus balanoides* from Budle Bay and Fenham Flats. The cyst is thin-walled and spherical (fig. 16), 0.04 mm. across. The cercaria is pale yellow and when pressed out of the cyst measures about 1 mm. in length. Very long prepharynx, longer than the oesophagus. Intestinal caeca reaching to just beyond the posterior border of the ventral sucker. Body covered with spines even at the posterior end.

It is interesting to note that small cysts with very thin walls are found with these large forms in *Balanus* and inside are curled up cercariae with stylets very like *Cercaria ubiquita*. This seems to show that the same kind of cercaria enters the *Balanus* and grows into the *Spelotrema* form.

Some time ago I suggested (1908 A, p. 10) that this was the encysted *Spelotrema excellens* but now think that the form so commonly found in the crab is much more likely to be this species.

The further life-history is not known.

Cercaria littorinae-rudis sp. inq.

(Lebour, 1906, p. 6.)

(Pl. XXVII, figs. 3-7.)

This cercaria was found only once occupying the digestive gland of a specimen of *Littorina rudis* from Holy Island, Northumberland, in the beginning of May. It is a specially interesting form as it shows a Trematode most certainly belonging to the *Spelotrema* group but yet with such a different form of cercaria, for no tail was observed and it probably has none. In form of the sporocysts and habit of the cercaria it is much more like *Gymnophallus*. Pelseneer (1906, p. 171) found in *Natica alderi* from Boulogne cercariae very much like these in similar sporocysts but there were much fewer cercariae in each.

The sporocysts are pale yellow and spherical about 1 mm. across and are full of cercariae more or less doubled up. This doubling up or folding is interesting as they closely resemble *Cercaria ubiquita* in this way. The cercaria (fig. 5) when extended measures 0.25 mm. in length and the body is covered with spines except at the posterior end. Unfortunately I have not got more detailed measurements of this species. The prepharynx is much shorter than the oesophagus,

intestinal caeca reaching to the posterior end of the ventral sucker. Genital opening on the left of the ventral sucker. Nicoll (ix. 1907, p. 255) considers this as very likely to be the larval form of *Spelotrema claviforme* (Brandes) from the dunlin *Tringa alpina* and the ringed plover *Aegialites hiaticula*.

The intermediate host is not known.

Cercaria oocysta mihi (1907 c, p. 445).

(Pl. XXVII, figs. 8, 9.)

Occurs encysted in sausage-shaped sporocysts in *Paludestrina stagnalis* from Fenham Flats and Loch Ryan. It occupies the digestive gland in 50 per cent. of those from Fenham Flats and two per cent. from Loch Ryan. The sporocysts are colourless and very thin-walled enclosing cercariae in all stages. The younger cercariae are tailed but the tail is soon lost and the worm settles down to encyst.

The cyst is thin-walled and a long oval 0.12×0.07 mm. The cast-off tails are to be seen moving about within the sporocyst. When all the cercariae are encysted the wall of the sporocyst dwindles and disappears.

The cercaria measures 0.24 mm. in length when pressed out of the cyst and is about $3\frac{1}{2}$ times as long as it is broad. The body is covered all over with spines. Oral sucker 0.026 mm. across, pharynx almost mid-way between the oral sucker and the bifurcation of the intestine but slightly further forward. Intestinal caeca reaching to about the level of the centre of the ventral sucker. Ventral sucker 0.019 mm. across. Lateral excretory canals can be made out faintly in the live worm. A cirrus sac opens on the left of the ventral sucker. Vitellaria and testes developed.

This cercaria was found in August at Loch Ryan and in the winter from Fenham Flats.

Further life-history not known, perhaps it is a species of *Maritrema*.

Cercaria pirum mihi (1907 c, p. 446).

(Pl. XXVII, figs. 10, 11.)

Occurs in the digestive gland of *Paludestrina stagnalis* in about four per cent. from Fenham Flats in July, October and December. The cercaria occurred in cysts all over the digestive gland and in those specimens examined in July the remains of the walls of the sporocysts

could be seen which were just breaking away. In the autumn and winter all traces of the sporocysts had gone and the cysts were quite free.

The cyst is spherical, 0.08 mm. across, quite transparent and colourless. The cercaria when pressed out of the cyst is 0.2 mm. long and very broad at the base. It is covered all over with small spines, more conspicuous near the head which appears very rough. Oral sucker 0.026 mm. across, ventral sucker about the same size occurring about three parts of the way down the body. Prepharynx very much shorter, long oesophagus, intestinal caeca reaching to about the level of the posterior border of the ventral sucker. The two lateral excretory canals unite behind the pharynx.

Nothing further is known of the life-history. It is very likely a species of *Maritrema* and perhaps the habit of encysting in the sporocyst may distinguish this genus from *Spelotrema*.

(d) *Stumpy-tailed Cercariae*.

Three different species belonging to this very well-marked group occur in Britain, one of which I have already recorded (1906, p. 5) *e.g.* *Cercaria linearis* Lespés, one which I now record as new to Britain *C. brachyura* (Lespés) and one new species. All are characterised by their very short stumpy tails which are incapable of independent movement and probably serve to attach the animal (acting as a sucker) whilst it is looking out for its intermediate host. The oral sucker is armed with a stylet and the stylet glands are conspicuous. The suckers are almost equal, the ventral sucker situated near the posterior end. The excretory vesicle is extremely thick-walled; the large lining cells making it appear almost solid.

Cercaria linearis Lespés (1857, p. 113).

(Pl. XXVII, figs. 12, 13.)

This cercaria occurs in *Littorina littorea* from Budle Bay and also from Millport. It is rare however, only being found in one specimen out of 190 examined from Budle and in one out of about the same number from Millport, both in July.

The sausage-shaped sporocysts are very inert and occupy the kidney and mantle cavity spreading also into most of the other organs. They measure 2.6 mm. in length and are a brilliant orange, the colour being due to granular masses scattered throughout the sporocyst. The

contained cercariae are colourless measuring 0.18 mm. in length including the tail, tail 0.015 mm. nearly square. Oral sucker 0.035 mm. armed with a stylet anteriorly cleft. By the side of the stylet open the four ducts of the stylet glands. The glands are conspicuous in front of the ventral sucker which measures 0.04 mm. across. The excretory vesicle is lined by very large conspicuous cells and opens posteriorly. The alimentary canal is not developed.

Further life-history not known.

Cercaria brachyura Lespés (1857, p. 113).

(Pl. XXVII, figs. 14-16.)

Occurs in the digestive gland of *Gibbula cinerea* from Loch Ryan and Millport. In two per cent. from Millport and only found once at Loch Ryan.

The sporocysts like the last species are a brilliant orange colour but they are very active and constantly change their shape. The young forms are redia-like although without pharynx and intestine, often showing processes like the ambulatory processes of a redia. This fact was noticed by Pelseneer (1906, p. 168) in what he takes to be this species¹. The older redia measures 1.2 mm. in length. The cercaria without its tail measures 0.24 mm. in length. The oral and ventral suckers are nearly the same size, the oral slightly larger than the ventral, oral sucker 0.05 mm. across when circular but often appears longer than it is broad. I could not see the stylet mentioned by Lespés and Pelseneer does not mention it. The stylet glands however are very conspicuous in front of the ventral sucker, opening by four ducts near the oral sucker. A pharynx is sometimes to be seen preceded by a short prepharynx, but I could not see any more of the alimentary canal. The excretory vesicle is lined by very thick cells. The body in some of the specimens was covered with minute spines. The tail usually looks broader than long and is slightly cleft posteriorly.

I think it is very likely to be a different species from Pelseneer's as his ventral sucker is larger than the oral and there are other small differences. It may be distinct from Lespés' species also, but they are all very much alike.

The further life-history is unknown. Pelseneer observed some of his specimens encysted in *Gibbula cinerea*. The tails had disappeared in three out of four specimens. In the fourth it had just come off.

¹ Pelseneer refers to it as *Cercaria pachycerca* Lespés.

Cercaria buccini sp. inq.

(Pl. XXVII, figs. 17, 18.)

This is the largest of the three cercariae belonging to this group. It occurs in *Buccinum undatum* brought in by the fishing boats, four out of 80 examined. It is contained in long and almost colourless sporocysts which occupy the digestive gland in enormous numbers. The gonad is not destroyed by this Trematode as is very usually the case with others.

The sporocysts measure 1.4 mm. to 3 mm. in length, pale yellow or colourless and sausage-shaped. They may be 20-30 cercariae in each sporocyst.

The cercaria measures 0.33 mm. including its tail, tail 0.06 mm., oral sucker 0.045 mm. across, armed with a stylet with four points anteriorly, the middle pair long and the outer short, bluntly rounded behind. The ventral sucker is situated well behind the centre of the body and is almost exactly the same size as the oral sucker. Between the two suckers are the stylet glands with six ducts, three on each side opening by the sides of the stylet anteriorly and dorsally. Behind the ventral sucker is a large excretory vesicle lined with very large cells.

Further life-history unknown.

(e) *Lepodora* group.

Genus *Lepodora*.

Lepodora rachiaea (Cobb.)? (Lebour, 1907 B, p. 102, and 1908 B, p. 20).

(Pl. XXVII, figs. 19, 20.)

The cercaria which is probably the larval stage of *Lepodora rachiaea* is very difficult to place in relation to any other larval forms. I have therefore left it at the bottom of the group developed in sporocysts.

It inhabits *Cardium edule* and is contained within sporocysts where it encysts. It was found twice by myself in cockles from Budle and Holy Island and once by Johnstone from Morecombe Bay completely riddling the visceral mass of the host.

The sporocysts are sausage-shaped and quite colourless. Sometimes they are active and constantly changing their shape, at other times they are quite inert. They measure about 0.60 mm. long and 0.15 mm. broad. Inside are cercariae in all stages, the older examples encysted

in spherical thin-walled cysts 0.14 mm. across or smaller. The young cercariae are tailed (tail not quite so long as the body) and very active inside the sporocysts. The tails disappear some time before encystment.

The cercaria when pressed out of the cyst measures 0.19 mm. in length. The body is covered with spines arranged in transverse rows. Oral sucker 0.04 mm. across, short prepharynx, conspicuous pharynx, short oesophagus, lobes of intestine reaching nearly to the posterior end of the body. Small ventral sucker slightly behind the centre of the body. Large bilobed excretory vesicle.

The specimens were obtained in March, April and October. Tailed forms were only obtained in October. Those found in the spring contained the encysted cercariae in the sporocysts which possibly had been resting through the winter.

The final host of *Lepodora rachiaea* is the haddock which feeds much on cockles. This cercaria is very like *L. rachiaea* and is in all probability that species which passes directly into its final host by the haddock eating the cockle.

2. *Cercariae developed in Rediae.*

(a) *Cercaria neptuneae* sp. inq.

(Pl. XXVIII, figs. 1, 2.)

This is most difficult to place as in some respects it resembles the stumpy-tailed cercariae, in others it is like *Acanthopsolus*, and in the possession of a huge tail it is unlike either.

It occurs in the digestive gland of *Neptunea antiqua* brought in by the Cullercoats fishing boats, and also from *Buccinum undatum* from the same locality in July. In both the reproductive organs are destroyed. The whole spire is packed with the rediae which are colourless and measure about 2 mm. or more in length. The redia has a pharynx 0.04 mm. long, and a very short intestine, hardly longer than the pharynx. It contains the cercariae in various stages.

The cercaria measures 0.4 mm. in length without its tail, breadth in extended condition about 0.10 mm., but very variable. The body is covered with small spines. Tail exceedingly large and thick forming an effectual swimming organ, length about 0.26 mm., breadth when moderately extended about 0.049 mm. Oral sucker 0.033 mm. across when circular but it can be elongated considerably so as to be longer than broad. Prepharynx 0.06 mm. long, pharynx 0.03 mm. long, rest of alimentary canal not visible. Two large eye-spots just in front and

to the sides of the pharynx. Ventral sucker at about the centre of the body, the same size or slightly smaller than the oral sucker. Large unicellular stylet glands at the sides of the ventral sucker opening by four long ducts near the oral sucker. A stylet was not seen but possibly there may be a very small one as these glands seem to indicate its presence. Another pair of glands just in front of the ventral sucker with long ducts are probably cystogenous glands. The very large excretory vesicle is oval and lined by large cells like those of the stumpy-tailed cercariae. This cercaria is very like the cercaria of *Allocreadium isoporum* Looss (1894, p. 54) which is developed in rediae in *Cyclas*. This has an enormous tail, eye-spots, prepharynx, pharynx and alimentary canal, conspicuous glands in the front part of its body. It is to be noted that the adult of this species has large unicellular glands ("head glands") opening near the oral sucker by long ducts. There is however an indication in Looss' figure of a stylet in the oral sucker of the cercaria.

It is just possible that *Cercaria neptuneae* may be the larval form of an *Allocreadium* or *Lebouria* Nicoll.

The further life-history is not known in any way.

(b) *Acanthopsolus* group.

Genus *Acanthopsolus* Odhner.

Acanthopsolus lageniformis mihi (1910, p. 29).

(Pl. XXVIII, figs. 3-6.)

Occurs in rediae in the digestive gland of *Buccinum undatum* in seven per cent. of those brought in by the Cullercoats fishing boats. Also it was found once in a specimen of *Buccinum undatum* from Holy Island.

The rediae are of various sizes, the older specimens being a pale yellowish. The smallest seen were about 0.30 mm. long and had no collar nor ambulatory appendages, hind end is pointed, pharynx and intestine conspicuous. These small rediae contained no cercariae. Larger specimens measuring from 0.50 mm. contained them, the intestine hardly growing at all, until in the large rediae of about 3 mm. it is so small that it can be easily overlooked. There may be 30 or more cercariae in each redia.

The young cercaria has a tail but it apparently loses it just before it is ready to emerge from the redia and in all probability there is no

free-swimming stage. The tail is slightly longer than the body, thin and very active.

The full-grown cercaria measures about 0.50 mm. in length, greatest breadth slightly less than half the length. Form of the body oval or more or less flask-shaped, the fore end more pointed than the hind end. Body covered all over with spines although they dwindle posteriorly. Two eye-spots conspicuous at the front end. Suckers almost the same size (0.06 mm. across), the oral slightly the larger. Conspicuous prepharynx and pharynx, short oesophagus, intestinal caeca reaching nearly to the posterior end of the body. Just behind the oral sucker are some small gland cells. Ventral sucker almost in the centre of body. Excretory vesicle large and pear-shaped, sometimes slightly bilobed anteriorly. Testes one on each side midway between ventral sucker and posterior end of body. Ovary in front of right testis. Sometimes traces of male and female ducts.

The final host is the catfish *Anarrhichas lupus* and it is very probable that there is no intermediate host, the fish swallowing the *Buccinum undatum* with the contained rediae, the cercaria thus getting into the intestine without the aid of another host. I have never seen any trace of cysts in the catfish.

The cercariae were found in the spring and summer, never in the winter.

(c) *Echinostomum* group.

Genus *Echinostomum* Rud.

Head end provided with a crown of spines open posteriorly. Excretory system with much branched lateral canals. Intermediate host a Mollusk or in exceptional cases the cercaria may encyst in its first host. Final host usually a bird.

The species of this genus are often very much alike, frequently possessing the same number of head spines. Three different cercariae are known to me all of which have 29 head spines. They can be quite easily distinguished however, as the rediae in which they are developed are quite distinctly different. I have no doubt that they represent different species. Moreover they are contained in constantly different hosts. In support of this it is to be noted that Dietz (1910, p. 352) recognises four species of *Echinostomum* (all belonging to his genus *Himasthla*) which have 29 head spines. Odhner (1910, p. 137) however regards at least three of these as the same species.

Echinostomum leptosomum Creplin.

(Villot, 1898, p. 18. Lebour, 1907 c, p. 447.)

(Pl. XXVIII, figs. 7-10.)

Occurs in colourless or pale yellow rediae in the digestive gland of *Paludetrina stagnalis* from Fenham Flats and Loch Ryan. In about 26 per cent. from Fenham Flats and one per cent. from Loch Ryan. It occurs in spring, summer, and early autumn, most plentifully in marshy pools above high water mark, although also in pools left uncovered for several hours in the day.

The rediae are all sorts of shapes which are constantly changing; the smallest seen were 0.20 mm. long, the largest 1.4 mm. long. The young forms are pointed at the hind end and have two conspicuous ambulatory processes each side which tend to disappear in the larger rediae. The cuticle in all is very thick and much wrinkled anteriorly especially round the mouth. The pharynx is large but the intestine can hardly be made out. All stages of cercariae are contained within the rediae. The full-grown cercaria is tailed, without the tail 0.40-0.50 mm. long, tail 0.3 mm. long and very thin and active. It is extremely transparent, very agile and fond of bending itself backwards in the form of a U. Body covered with spines except at the posterior end. Head end with a crown of 29 head spines arranged in a row round three parts of the head two at each end being below the others but very little smaller (long spines 0.019-0.02 mm., short spines 0.016 mm.), oral sucker 0.030 mm. across, prepharynx rather long, pharynx 0.026 mm. long, oesophagus long and narrow with intestinal caeca reaching nearly to the posterior end of the body. Ventral sucker 0.046 mm. across. Excretory vesicle roundish, with two much branched lateral canals filled with clear granules. Ducts of glands opening near anterior end. Gland cells all over body. In one case an encysted cercaria was found among the rediae but this is an exception as there is an intermediate host. The cercaria leaves the first host and swims about, finally getting into *Scrobicularia tenuis*. This small bivalve is very common on Fenham Flats and the cercaria encysts in the foot as described by Villot. The cyst measures 0.12 mm. across with a thin transparent wall of two layers.

The final host is the turnstone *Streptilas interpres* in which *Echinostomum leptosomum* is quite common. Villot found it in the dunlin *Tringa alpina* and I have also found it in this bird. Both feed on *Scrobicularia tenuis*.

Echinostomum secundum Nicoll (I. 1906, p. 151, III. 1906, p. 515),

(Lebour, 1905, p. 1, 1906, p. 3, and 1908 c, p. 354.)

(Pl. XXVIII, figs. 11-14.)

Occurs in the digestive gland of the common periwinkle *Littorina littorea* from Budle and Fenham Flats in about three per cent. in spring, summer, and early autumn, also in about five per cent. from Loch Ryan. The spire of the animal is always a brilliant orange and can easily be distinguished from healthy specimens which are not infected. The colour is due to the redia which is a bright pinkish orange when full grown. The very young rediae are colourless, the smallest seen was 0.40 mm. long, with a conspicuous pharynx and intestine, collar, and two ambulatory processes posteriorly. The anterior part between mouth and collar is grooved. The collar and grooves disappear and the ambulatory processes gradually dwindle in the full-grown redia, but there is always a trace of one of the processes, the redia having the shape of a stocking; it may be 2 or more mm. long, and is much more constant in shape than *E. leptosomum*.

The cercaria is colourless and transparent, length 0.70 mm. without tail which is not quite so long as the body. Body covered for the first two-thirds with small spines. Head armed with 29 spines arranged as in *E. leptosomum* but with the two short spines at each end, which are on a lower level, much shorter than the others. Oral sucker 0.065 mm. across, leading to a thin prepharynx, pharynx 0.05×0.03 mm., narrow oesophagus with intestinal caeca reaching nearly to the posterior end of body. Ventral sucker 0.095 mm. across. Excretory vesicle oval, two much branched lateral canals full of clear granules. Cystogenous ducts opening by oral sucker.

The cercaria leaves its first host and swims freely in the water until it reaches its intermediate host, which in this case is the common mussel *Mytilus edulis* in which it settles down and encysts in the foot. I have determined by experimental infection that this cercaria passes from the periwinkle to the mussel and encysts in the foot of the mussel (1909, p. 353). Cysts which are almost identical with these and probably the same species were also found in *Cardium edule*, *Mya arenaria* and *Tapes pullastra*. The cysts project from the foot in well-infected specimens as small papillae dotted all over it. Each cyst measures 0.21-0.25 mm. across, and, except for the size, is exactly

like *E. leptosomum*. Almost every mussel at Budle contains these cysts and about 10 per cent. of the cockles. It is also common at Fenham Flats and Loch Ryan encysted in the mussels and cockles. The final host according to Nicoll (III. 1906, p. 515) is the oyster catcher *Haematopus ostralegus*, also the herring-gull *Larus argentatus* and the black-headed gull *L. ridibundus*, in which birds an *Echinostomum* occurs, which was traced by Nicoll from very young forms almost exactly corresponding to the above-mentioned cercaria to the adults, which he has described as *E. secundum*. I think from the evidence of the cercariae and rediae there is no doubt that these are distinct species. The third form which I believe to be also a distinct species is described below.

Echinostomum sp.

Cercaria littorinae obtusatae sp. inq.

(Pl. XXVIII, figs. 15–17.)

Occurs in the digestive gland of *Littorina obtusata* from Millport in about five per cent. It looks a pale yellowish-brown when infected but the redia is quite colourless and peculiar in having an extremely small pharynx and intestine even in the young forms. The smallest redia seen was 0.5 mm. long, of a squarish form with a conspicuous collar and more or less pronounced ambulatory processes. Pharynx very small with intestine not reaching half-way down the body. The older rediae measured 2–3 mm. in length, the pharynx so inconspicuous that it was difficult to see it at all and the intestine is actually smaller than in the youngest redia seen. The large rediae were full of cercariae in various stages.

The cercaria is extremely like *E. secundum*, the smaller head spines however are not so short as those in *E. secundum*. Length of body 0.78 mm., tail 0.4 mm. long. Body covered with spines for the first two-thirds of its length. 29 head spines. Oral sucker 0.06 mm. across, ventral sucker 0.08 mm. across. Excretory system with much branched lateral canals, the granules contained in them soon disappearing so that the clear canals are specially easy to see, and the part continued into the tail can clearly be made out bifurcating a little more than half-way down. In *E. leptosomum* and *E. secundum* it also is continued into the tail but cannot be so clearly seen.

The further life-history of this species is not known.

Cercaria purpurae sp. inq.

(Lebour, 1907 B, p. 102.)

(Pl. XXIX, figs. 1-3.)

This cercaria which I have before described from the dog-whelk *Purpura lapillus* undoubtedly belongs to the *Echinostomum* group although certainly to another genus. Having found it much more frequently than before I am able to describe it more in detail. It occurs in the digestive gland of *Purpura lapillus* from Budle Bay, Fenham Flats, Loch Ryan and Millport. It is the commonest at Millport in about 20 per cent. in spring, summer, and early autumn, but not in the winter. The infected gland is swollen and of a pale yellowish colour, packed full of rediae. The redia is pale yellow or colourless with a bright yellow intestine. The young forms are the most perfectly typical rediae that I know. They measure 0.32-0.60 mm. in length and are narrow and quite colourless. The pharynx is conspicuous and leads to a large intestine occupying about half the length of the body. Anteriorly and to the side is a thick-lipped birth-pore which is capable of protrusion or withdrawal. A collar is not present. Two very mobile ambulatory processes occur posteriorly one on each side of the pointed hind end, and these are also capable of being retracted completely or exerted for quite a long distance. These young rediae are to be found in the mantle cavity and also in the digestive gland and most probably migrate from one organ to the other. The sporocyst in all probability occurs in the mantle cavity and gives rise to rediae which migrate to the digestive gland where they feed and multiply enormously, finally giving rise to cercariae. The older redia loses its hind appendages but its pharynx and intestine are still conspicuous when it is full of cercariae. The full-grown redia may be 3.6 mm. long. The cercaria is very solid and thick but extremely active. Length of body 0.64 mm. without tail which is 0.42 mm. long. The tail is very thin with a sucker-like end. There is no indication of a continuation into it of the excretory system. Body entirely covered with broad scale-like spines except in the head region and the region of the ventral sucker. The inside of the body is occupied by large gland cells arranged in four groups, the ducts from which run together on each side expanding into six smaller ducts on each side which open by the oral sucker. The head is extremely complicated and beset with numerous spines and papillae. There is a considerable space, the neck, between the flat body spines and the

head, and this head bear a row of fine spines arranged as far as I can make out as a crown undulating on the ventral surface, straight dorsally. The oral sucker has papillae arranged round its opening and there are also papillae round the oral sucker. Oral sucker 0.06 mm. across, short prepharynx, small but muscular pharynx. Oesophagus long, reaching to about the centre of the body where it bifurcates, intestinal caeca reaching nearly to the posterior end of the body. Ventral sucker 0.099 mm. across but with the space round it may appear much larger and it is difficult to define its limits. Excretory vesicle round receiving two thick lateral canals.

Here we have a very characteristic and common form but nothing further is known of its life-history. It almost certainly inhabits a bird in its adult state.

It is interesting to note that full-grown cercariae were found in the mantle cavity of *Purpura* together with the very young rediae, which seems to indicate that the cercaria emerges from its host by the same route that the redia uses to get to the digestive gland.

Cercaria patellae sp. inq.

(Lebour, 1907 B, p. 103.)

(Pl. XXIX, figs. 4, 5.)

This cercaria occurred once in the digestive gland of *Patella vulgata* from Loch Ryan out of 16 examined in September. The gonad was completely destroyed.

Redia colourless, long and transparent, 1.8 mm. or more in length. Pharynx conspicuous but no intestine could be seen. All the rediae were full of tailed cercariae.

The cercaria measures 0.50 mm. in length with the tail thin and measuring less than half the length of the body and abruptly truncated. Body covered with small spines. Head surrounded by two complete rows of longer spines. Oral sucker leads to a narrow prepharynx, muscular pharynx, long oesophagus branching into caeca reaching nearly to the posterior end of the body. Ventral sucker behind the centre of the body. Excretory vesicle receiving two unbranched lateral canals full of bright granules.

Nothing further is known of the life-history.

I had thought it was possibly a *Stephanochasmus* but it is very probably, as suggested to me by Dr Nicoll, that it is the cercaria of *Echinostephilla virgula* which I have described from the turnstone (1909, p. 3).

Genus *Stephanochasmus* Looss.

Head with two complete rows of spines. Intermediate host—fish, final host—fish.

Stephanochasmus baccatus Nicoll (I. 1907, p. 80, Lebour, 1908 A, p. 14).
(Pl. XXIX, figs. 6, 7.)

The encysted form is very common under the skin of Pleuronectid fishes, the dab *Pleuronectes limanda* L., witch *P. cynoglossus* L., lemon dab *P. microcephalus* Donovan., and long rough dab *Hippoglossus limandoides* Bloch, all being infected on the Northumberland Coast. Johnstone (1904, p. 98) has recorded and described it from the West Coast of England and Nicoll and Small (1909, p. 244) from Millport. The cercaria occurs beneath the skin on the under side and sometimes on the gills, the fish serving as the intermediate host. The cyst is composed of two layers, the first thick and tough, the second transparent.

The cercaria when pressed out of the cyst measures 2.9–3 mm. in length. It is pear-shaped with a very long neck, the body covered with spines which gradually disappear posteriorly. They are large near the head and surrounding the head are two rows of very long pointed spines, those in the upper row shorter than those in the lower (upper spines 0.022 mm. long, lower 0.026 mm. long). The number is variable, from 48 to 58 spines in two uninterrupted rows of 24 to 29 spines each. Nicoll thinks it probable and it seems to be very likely that we have to do with several different species. Oral sucker 0.26 mm. across, prepharynx 0.50 mm. long, pharynx 0.18 mm. long, very muscular leading to broad oesophagus branching into two coeca which reach nearly to the posterior end of the body. Genital aperture immediately in front of ventral sucker. Ventral sucker 0.23–0.26 mm. across. Two round testes and an ovary occur at the hind end of the body. Vasa deferentia joining a thin club-shaped vesicula seminalis in front of which the cirrus sac encloses a small cirrus. Oviduct short, other female organs not yet developed. Excretory vesicle very large, circular and opaque occupying the posterior region.

This cercaria is probably *Stephanochasmus baccatus* Nicoll, which he found in the halibut *Hippoglossus vulgaris* Flem. This worm has 56 spines round its head. As Nicoll suggests however there may be *S. caducus* and *S. triglae* as well as *S. baccatus* encysted in these fish and we may have examples of them all.

Other encysted Distomes have been observed but it is impossible to assign to them any position in this scheme as the younger stages are not known. These are *Cercaria limae* Nicoll and Small, *C. concava* Nicoll and Small and a cercaria which I have found frequently encysted in the mussels and cockles of Northumberland and the West Coast of Scotland, Nicoll (III. 1907, p. 91) also records an encysted Trematode from the skin, muscles, bones and layers of the eye of a *Cottus bubalis* from St Andrews, which was rendered completely blind by the parasite. He was not able to identify it. In the same work he also mentions an encysted Distomid from the gills of *Cottus scorpius* and *Gobius ruthens-parri*.

I have not myself observed the following two cercariae. The descriptions are taken from those of Nicoll and Small (1909, p. 242) who kindly allow me to reproduce their figures.

Cercaria limae Nicoll and Small (1909, p. 242).

(Pl. XXIX, fig. 8.)

This was found in single isolated cysts in *Lima hians* from Millport. Cyst spherical, about 0.3 mm. in diameter, with thin opaque membranous wall. Cercaria 0.60 mm. long, elongated oval outline, colourless and transparent. Suckers globular, oral sucker 0.12 mm., ventral 0.152 mm., latter situated at the beginning of the posterior third of the body. Cuticle smooth. Two small oval testes just behind ventral sucker, their long axes directed obliquely outwards and forwards. Short excretory vesicle. Small pharynx contiguous with oral sucker. Intestinal diverticula arise immediately behind pharynx and appear to terminate near testes. The authors think this is the larval form of a *Steringophorus* or *Fellodistomum*, the latter parasitic in its adult state in the catfish *Anarrhichas lupus* and the former in various Pleuronectids.

Cercaria concava Nicoll and Small (1909, p. 243).

(Pl. XXIX, fig. 9.)

Found in a young plaice *Pleuronectes platessa* contained in a small round cyst embedded under the skin. It measured 0.17 mm. in diameter, very thin-walled so that the cercaria was easily liberated. Shape of the cercaria flattened, considerably broader towards the posterior end than towards the anterior end. Length 0.48 mm., greatest

breadth 0.22 mm., oral sucker small, round, 0.06 mm. across, prepharynx 0.03 mm. long, pharynx 0.04 mm., oesophagus 0.04 mm. Intestinal diverticula bend in towards the middle line in the vicinity of the genital sucker, then curve out and again approach each other posteriorly. Excretory vesicle clearly seen, consisting of two fairly straight lateral tubes, beginning near the pharynx and running into a simple, rather wide terminal sac at the posterior end of the body. Genital sucker about the middle of the body, not a true ventral sucker. Vestigial ventral sucker in front of genital aperture. Traces of two small testes in front of the ends of the intestinal diverticula. Cuticle covered with scale-like spines.

The authors regard this as the larval form of *Cryptocotyle concava* (Crepl.) which they have found in the adult state in the shag *Phalacrocorax graculus* which feeds, as they state, largely on small plaice, dabs and flounders.

T. Scott (1909, p. 78) records an encysted Distomid from the walls of the stomach of a witch *Pleuronectes cynoglossus* from the Moray Firth. He thinks it is very probably the cercaria of *Distomum cestoides* Ed. van Beneden which he records from the oesophagus of the skate *Raia batis*, Aberdeen. He very kindly sent me specimens of the adults which are slightly different from those I have described from the starry ray *R. radiata* as *Otodistomum veliformum* (Creplin).

Cercaria mytili sp. inq. (Lebour, 1906, p. 5).

(Pl. XXIX, fig. 10.)

This occurs commonly encysted in the digestive gland of the mussel *Mytilus edulis* and cockle *Cardium edule*, chiefly in the mussel from Northumberland and the cockle on the West Coast of Scotland. The cyst is spherical and thick-walled but quite transparent, 0.20 mm. across. Very little could be made out of the structure of the cercaria as it was nearly always damaged when pressed out of the cyst.

Cercaria 0.46 mm. long, covered with spines. Posterior end pointed, head end rounded. Oral and ventral suckers about the same size 0.06 mm. across. Ventral sucker just behind the centre of the body. Alimentary system not seen. Excretory system very conspicuous in the cercaria curled up in the cyst. Two lateral canals full of clear granules.

Further life-history unknown.

(d) *Monostomum* group.

Cercaria ephemera Nitsch (= *Monostomum flavum* Mehlis),
Lebour (1907 c, p. 436).
(Pl. XXIX, figs. 11, 12.)

This cercaria is not the larval form of *Typhlocoelum flavum* (Mehlis) as was formerly thought: the ends of the forks of the alimentary canal are not joined as they are in that genus. I have therefore returned to the name *Cercaria ephemera* given by Nitsch. It occurs in the digestive gland of *Paludetrina stagnalis* from Fenham Flats and Loch Ryan; in about six per cent. from Fenham Flats and 20 per cent. from Loch Ryan in August and November. The redia is yellowish with a dark brown intestine, well developed pharynx but no thickening round the mouth. It is active and contains cercariae in all stages.

The cercaria measures 0.24 mm. in length without its tail which is slightly longer than the body. It is opaque and speckled with brown with a brownish tinge all over the body. Anteriorly there are three conspicuous eye-spots arranged in a triangle. The body at each side of the base of the tail is drawn out and provided with a small sucker-like structure which apparently helps to fix the cercaria whilst the anterior part of the body is extended. The oral sucker is large and leads to the oesophagus which bifurcates just behind the anterior eye. There is no pharynx. The lobes of the intestine extend nearly as far as the posterior end of the body. The excretory vesicle is a clear sac at the hind end of the body with two conspicuous lateral canals full of clear granules opening into it.

The further life-history is not known but it apparently belongs to the family *Notocotylidae* Lhe., which live in the intestinal caeca and rectum of sea birds. Lühe (1909, p. 178) thinks it may be *Notocotyle triseriale* Dies. or *Catatropis verrucosa* (Fröl.), both of which live in a variety of sea birds, more particularly ducks. This species is perhaps identical with *Cercaria imbricata* Looss which he regards as the larval form of *Notocotyle triseriale* Dies. (1896, p. 192). *C. imbricata* occurs in *Bythinia tentaculata*. The usual habitat of *C. ephemera* is *Planorbis corneus* a purely fresh water Mollusk.

Cercaria lophocerca Fil. (Lebour, 1907 c, p. 443).

(Pl. XXIX, figs. 13-15.)

This peculiar cercaria occurs in the digestive gland of *Paludetrina stagnalis* from Fenham Flats (in about 40 per cent.) and Loch Ryan (15 per cent.) and also occurs in the digestive gland of the periwinkle

Littorina littorea at Millport (10 per cent.) in spring, summer and early autumn. There is a great reduction in their numbers in autumn and winter. The appearance of a periwinkle infected with it is very unhealthy, the digestive gland being a curious greyish yellow. The gonad is destroyed.

The cercaria is contained in colourless rediae with a yellowish brown intestine. The redia can be very active and constantly changing its shape. The young forms are striated transversely and have no collar nor ambulatory processes, they measure about 0.16 mm. in length. Older rediae 1.4 mm. long or longer with thickened mouth, small pharynx and conspicuous intestine. Cercaria 0.2 mm. long without its tail which may be more than three times the length of the body and provided with a very thin fin placed dorsally and ventrally for its whole length. By the aid of this finned tail the cercaria whizzes about in a most characteristic manner.

The body is covered with spines. Anteriorly are two dark eye-spots one on each side of the oral sucker. Oral sucker 0.35 mm. across when at rest but it is constantly being elongated and protruded like a snout. No alimentary canal can be made out. Most of the body is occupied by two large masses of gland cells with long straight ducts running forward and opening by the oral sucker. The excretory vesicle is bilobed and oval with its long diameter transverse.

The further life-history is not known.

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DESCRIPTION OF PLATES XXV TO XXIX.

The following letters apply to all the figures.

<i>C.</i> cercaria.	ÆS. œsophagus.
<i>C.G.</i> cystogenous glands.	<i>O.S.</i> oral sucker.
<i>C.O.</i> cystogenous organs.	<i>P.</i> pharynx.
<i>C.S.</i> cirrus sac.	<i>P.PH.</i> prepharynx.
<i>E.</i> eye.	<i>S.</i> sporocyst.
<i>E.V.</i> excretory vesicle.	<i>S.G.</i> stylet glands.
<i>G.</i> gland cells.	<i>S.G.D.</i> ducts of stylet glands.
<i>G.A.</i> genital aperture.	<i>ST.</i> stylet.
<i>I.</i> intestine.	<i>T.</i> testis.
<i>L.C.</i> lateral canal.	<i>V.</i> vitellaria.
<i>O.</i> ovary.	<i>V.D.</i> vas deferens.
<i>OD.</i> oviduct.	<i>V.S.</i> ventral sucker.

PLATE XXV.

- Figs. 1-4. *Gasterostomum gracilescens* (Rud.).
1. Portion of sporocyst (length 1 mm.).
 2. *Bucephalus haimeanus* (length 0.3 mm.).
 3. Encysted cercaria (long axis 0.6 mm.).
 4. Cercaria pressed out of cyst (length 2.6 mm.).
- Figs. 5, 6. *Gasterostomum* sp.
5. Portion of sporocyst.
 6. *Bucephalus syndosmyæ* sp. inq. (length 0.26 mm.).
- Figs. 7, 8. *Gymnophallus* sp.
7. Part of cockle from under umbo containing sporocysts with cercariae.
 8. *Cercaria margaritæ* sp. inq. (length 0.2 mm.).
- Fig. 9. *Cercaria scrivenensis* sp. inq. (length 0.4 mm.).
- Fig. 10. *Cercaria glandosa* Lebour (length 0.2 mm.).
- Fig. 11. *Cercaria macomæ* Lebour (length 0.7 mm.).
- Fig. 12. *Cercaria strigata* Lebour (length 0.3 mm.).

PLATE XXVI.

- Figs. 1, 2. *Cercaria dichotoma* Müller.
1. Sporocyst (length 1 mm.).
 2. *Cercaria dichotoma* Müller (length 0.2 mm.).

- Figs. 3-12. *Spelotrema excellens* Nicoll.
 3. Sporocyst (length 0·6 mm.).
 4. Tailed cercaria (= *Cercaria ubiquita*) (length 0·12 mm.).
 5-6. The cercaria having just entered *Carcinus maenas* and covered itself with a very thin cyst (0·014 mm. across).
 7-11. Are various stages in the encystment of the cercaria drawn in proportion.
 12. The cercaria pressed out of the cyst (length 0·8 mm.).
- Figs. 13, 14. *Cercaria carcini* Lebour.
 13. Cercaria bursting out of cyst (length of cyst 0·4 mm.).
 14. Cercaria pressed out of cyst (length 0·54 mm.).
- Figs. 15-17. *Cercaria balani* Lebour.
 15. Encysted cercaria (cyst 0·4 mm.).
 16. Cercaria pressed out of cyst (length 1 mm.).
 17. Small cyst from *Balanus balanoides* (0·15 mm.).
- Figs. 18, 19. *Cercaria corophii* Lebour.
 18. Encysted cercaria (length of cyst 0·16 mm.).
 19. Cercaria pressed out of cyst (length 0·34 mm.).

PLATE XXVII.

- Figs. 1, 2. *Cercaria minor* sp. inq.
 1. Encysted cercaria (cyst 0·26 mm.).
 2. Cercaria pressed out of cyst (length 0·52 mm.).
- Figs. 3-7. *Cercaria littorinae-rudis* sp. inq.
 3. Sporocysts (1 mm. across).
 4. Cercaria pressed out of cyst (length 0·25 mm.).
 5-7. Different aspects of cercariae within sporocyst.
- Figs. 8, 9. *Cercaria oocysta* Lebour.
 8. Sporocyst with encysted cercariae (length 0·12 mm.).
 9. Cercaria pressed out of cyst (length 0·24 mm.).
- Figs. 10, 11. *Cercaria pirum* Lebour.
 10. Encysted cercaria (cyst 0·08 mm.).
 11. Cercaria pressed out of cyst (length 0·2 mm.).
- Figs. 12, 13. *Cercaria linearis* Lespés.
 12. Sporocyst (length 2·6 mm.).
 13. Cercaria (length 0·18 mm.).
- Figs. 14-16. *Cercaria brachyura* Lespés.
 14. Young sporocyst (length 0·2 mm.).
 15. Older sporocyst (length 1·2 mm.).
 16. Cercaria (length 0·26 mm.).
- Figs. 17, 18. *Cercaria buccini* sp. inq.
 17. Sporocyst (length 1·4 mm.).
 18. Cercaria (length 0·33 mm.).
- Figs. 19-21. *Lepodora rachiaea* (Cobb).
 19. Sporocyst containing encysted cercariae (length 0·60 mm.). From a drawing by Mr Jas. Johnstone.
 20. Cercaria pressed out of cyst (length 0·19 mm.).
 21. Young tailed cercaria.

PLATE XXVIII.

- Figs. 1, 2. *Cercaria neptuneae* sp. inq.
 1. Redia (length 2 mm.).
 2. Cercaria (length without tail 0.4 mm.).
- Figs. 3-6. *Acanthopsolus lageniformis* Lebour.
 3. Young redia (length 0.3 mm.).
 4. Older redia (length 3 mm.).
 5. Young tailed cercaria.
 6. Cercaria (length 0.5 mm.).
- Figs. 7-10. *Echinostomum leptosomum* Creplin.
 7. Young redia (length 0.2 mm.).
 8. Older redia (length 1.4 mm.).
 9. Cercaria (length without tail 0.5 mm.).
 10. Encysted cercaria (cyst 0.12 mm.).
- Figs. 11-14. *Echinostomum secundum* Nicoll.
 11. Young redia (length 0.4 mm.).
 12. Older redia (length 2 mm.).
 13. Cercaria (length 0.7 mm.).
 14. Encysted cercaria (cyst 0.23 mm.).
- Figs. 15-17. *Echinostomum* sp. *Cercaria littorinae obtusatae* sp. inq.
 15. Young redia (length 0.5 mm.).
 16. Older redia (length 2.5 mm.).
 17. Cercaria (length 0.78 mm.).

PLATE XXIX.

- Figs. 1-3. *Cercaria purpurae* sp. inq.
 1. Young redia (length 0.32 mm.).
 2. Older redia (length 3 mm.).
 3. Cercaria (length without tail 0.64 mm.).
- Figs. 4, 5. *Cercaria patellae* sp. inq.
 4. Redia (length 1.8 mm.).
 5. Cercaria (length 0.5 mm.).
- Figs. 6, 7. *Stephanochasmus baccatus* Nicoll.
 6. Encysted cercaria.
 7. Cercaria pressed out of cyst (length 2.9 mm.).
- Fig. 8. *Cercaria limae* Nicoll and Small (length 0.6 mm.) from Nicoll and Small (1909, p. 242).
- Fig. 9. *Cercaria concava* Nicoll and Small (length 0.48 mm.) from Nicoll and Small (1909, p. 243).
- Fig. 10. *Cercaria mytili* sp. inq. (cyst 0.2 mm.).
- Figs. 11, 12. *Cercaria ephemera* Nitsch.
 11. Redia.
 12. Cercaria (length 0.24 mm.).
- Figs. 13-15. *Cercaria lophocerca* Fil.
 13. Young redia (length 0.16 mm.).
 14. Older redia (length 1.4 mm.).
 15. Cercaria (length without tail 0.2 mm.).

